Epizoic Limpets on the Black Turban Snail, *Tegula funebralis* (A. Adams, 1855)

BY

BETH A. BREWER

Department of Biology, University of California at Santa Cruz, Santa Cruz, California 95064
and Bodega Marine Laboratory of the University of California, Bodega Bay, California 94923 [1]

(1 Text figure)

INTRODUCTION

Epizoic limpets on the mid-intertidal black turban snail *Tegula funebralis* (A. Adams, 1855) have been consistently identified as *Collisella asmi* (Middendorff, 1849) (= *Acmaea asmi*) (Test, 1945; Smith & Gordon, 1948; Fritchman, 1961; Eikenberry & Wickizer, 1964; Alleman, 1968; Bishop & Bishop, 1973). There has been no recording of other limpets occurring on *T. funebralis* in the published literature. However, McLean (unpublished Ph. D. thesis, 1966) found at Pacific Grove, Monterey County, California, that *C. strigatella* (Carpenter, 1864) occurred as abundantly as *C. asmi* on *T. funebralis*.

The results of an ecological survey of the species of limpets found on *Tegula funebralis*, and their frequencies and size ranges, are presented here. The number of limpets per shell, and the sizes of both limpets and *Tegula* were studied for possible correlations.

MATERIALS AND METHODS

From July through August, 1973, the 5 California beaches studied were: Shell Beach, Doran Beach, and Mussel Point in the Bodega Bay area, Sonoma County; Duxbury Reef in Marin County; and Flatrock Point on the Palos Verdes Peninsula in Los Angeles County. Shell Beach and Doran Beach have large boulders interspersed with sand in a semiprotected area. Mussel Point is on the exposed rocky coast. Duxbury Reef and Flatrock Point are flat, protected rocky reefs.

At each beach *Tegula funebralis* were collected in 5 one-meter square quadrats placed wherever a large *T. funebralis* population could be found. Random sampling would have provided insufficient numbers of *Tegula* because populations were sparse at several beaches. *Tegula funebralis* without limpets were counted and returned. *Tegula* with limpets were collected, counted, measured for height and width, and then returned. Epizoic limpets were similarly analyzed and identified to species. Limpets from Mussel Point and most of those from Duxbury Reef were returned since these areas are marine biological reserves. The remaining limpets used in this study have been deposited in the California Academy of Sciences in San Francisco.

All measurements for *Tegula funebralis* and limpet height were made with a caliper (0.2 mm accuracy); limpet width and length were measured with a microscope micrometer (0.1 mm accuracy).

Limpets were identified using Carlton & Roth (1974), McLean (1969), personal notes of J. T. Carlton, and specimens from the California Academy of Sciences. On the basis of extensive observations, juveniles could be identified and related to the various adult species or followed through growth series to the adult appearance.

RESULTS

In the present study 7 species of limpets were found on *Tegula funebralis*; *Collisella asmi* was not the most abundant (Figure 1). The 7 species were: *C. asmi*, *C. digitalis* (Rathke, 1833); *C. limatula* (Carpenter, 1864); *C. pelta* (Rathke, 1833); *C. scabra* (Gould, 1846); *C. strigatella*; and *Notoacmea scutum* (Rathke, 1833). *Collisella pelta*

[1] Permanent address: 15 Vista Del Orinda Road, Orinda, California 94563

was the most abundant species (average of 72% frequency) in the Bodega Bay area; Shell Beach and Doran Beach had a frequency of less than 10% for all other species, including *C. asmi*. At Mussel Point, no *C. asmi* were found, and *C. digitalis* was the second most common species with 27% frequency. *Collisella pelta* and *C. asmi* from Duxbury Reef occurred in nearly equal frequencies of 50% and 49% respectively, while *C. digitalis* and *C. strigatella* displayed a frequency of 1%. At Flatrock Point, limpets on *T. funebralis* were almost exclusively *C. strigatella* (90%), while 9% were *C. limatula* and 1% *C. scabra*. No *C. pelta*, *C. asmi* or *C. digitalis* were found at this southern California locality on *T. funebralis*, in contrast to the central California areas surveyed, although the range of all 3 species extends south of Los Angeles.

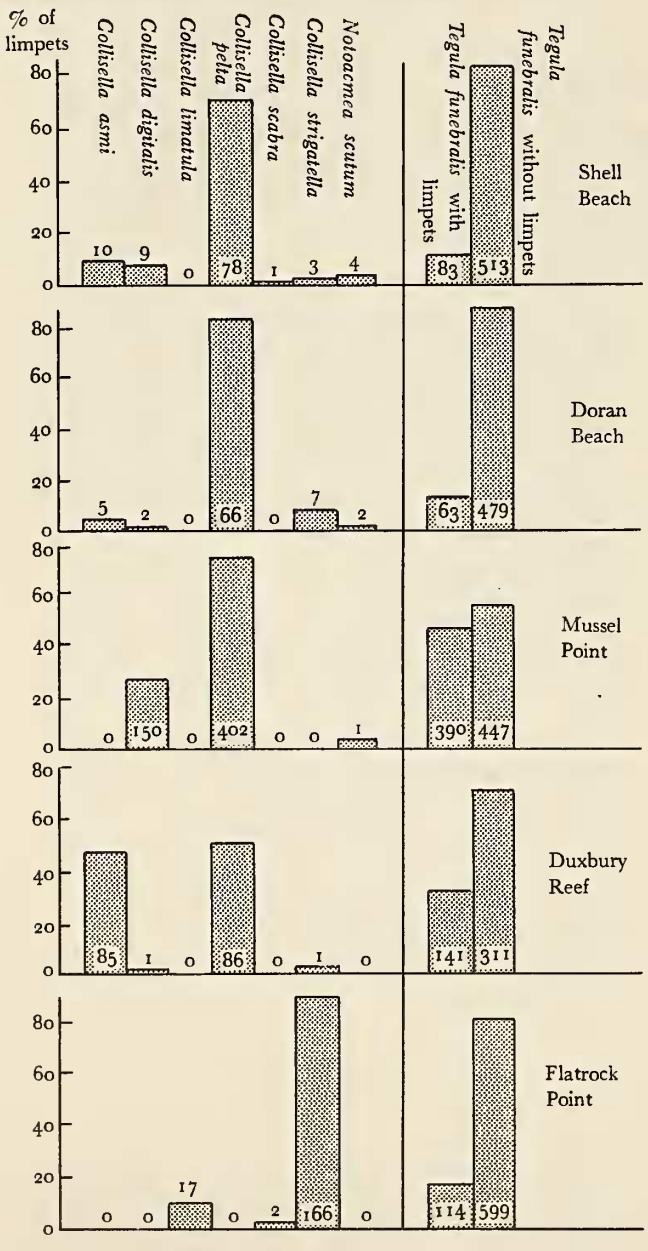

Figure 1

Frequencies of the species of limpets found at the five localities

Size ranges and means for limpet heights and lengths for all localities are shown in Table 1. The limpets examined had a small size range with none larger than 10.6 mm in length or 7.7 mm in height. *Collisella asmi* and *Notoacmea scutum* had the largest individual shell measurements. However, a total of only 7 *N. scutum* were found of which only one was larger than the largest *C. asmi*. *Collisella asmi* had the largest average measurement and was the only limpet to attain adult size on *Tegula funebralis*.

The number of *Tegula* with limpets varied markedly from locality to locality, ranging from 47% at Mussel Point to 12% at Doran Beach (Figure 1). Those *Tegula* with limpets were found to have approximately the same average number of limpets per shell at all localities, ranging from 1.2 to 1.6. However, the maximum number of limpets per *Tegula* at each locality varied considerably more than the average, ranging from 7 on one *Tegula* at Mussel Point, to 3 limpets on one *Tegula* at Duxbury Reef. The maximum number of different species on one turban snail was 3 at Flatrock Point, and 2 at every other locality.

The hypothesis of a random number of limpets per *Tegula funebralis* was tested using a Chi Square (X^2) Goodness of Fit. The expected number of limpets per *Tegula* was calculated by a Poisson distribution involving the mean number of limpets per *Tegula*. Results showed a random distribution of all species of limpets only at Duxbury Reef, a protected locality. For *Collisella pelta*, a random distribution occurred at Duxbury Reef and Mussel Point, where *Tegula* were found in the protection of the mussel bed. A deviation from a random distribution was observed for all species of limpets at Shell Beach, Doran Beach and Mussel Point and for *C. pelta* at Shell and Doran Beaches which were more exposed environments. The occurrence of 0 or 2 or more limpets per *Tegula* was enhanced compared to only 1 limpet. This deviation from a random distribution seemed to be greater with more unprotected environments. Regressions computed from combined data of the 5 localities for each

Table 1

Mean Limpet Measurements ± Standard Deviations and Ranges (mm)

	Collisella asmi	*Collisella digitalis*	*Collisella limatula*	*Collisella pelta*	*Collisella scabra*	*Collisella strigatella*	*Notoacmea scutum*
Shell Beach							
Length	7.5 ± 2.1	3.5 ± 1.5		3.4 ± 1.4	3.5	5.1 ± 0.7	6.1 ± 3.5
(Range)	(3.1-9.7)	(1.8-6.0)		(1.4-7.2)		(4.9-5.5)	(2.1-10.6)
Height	3.8 ± 1.5	1.2 ± 0.5		1.0 ± 0.5	1.3	2.1 ± 0.5	1.2 ± 0.6
(Range)	(0.9-5.9)	(0.6-2.0)		(0.3-2.6)		(1.6-2.8)	(0.6-2.1)
Doran Beach							
Length	4.9 ± 0.9	4.6 ± 0.3		3.1 ± 1.6		5.9 ± 0.9	7.5
(Range)	(3.2-5.5)	(4.4-4.8)		(1.1-7.7)		(4.8-7.3)	(5.5-8.8)
Height	2.4 ± 0.7	1.4 ± 0.3		1.0 ± 0.5		2.2 ± 0.4	1.5
(Range)	(1.2-2.9)	(1.2-1.6)		(0.4-2.5)		(1.6-2.8)	(1.0-2.0)
Mussel Point							
Length		2.6 ± 1.8		4.0 ± 1.3			6.3
(Range)		(1.4-8.6)		(0.9-8.7)			
Height		0.8 ± 0.3		1.2 ± 0.2			1.1
(Range)		(0.3-2.1)		(0.2-3.4)			
Duxbury Reef							
Length	7.3 ± 1.9	2.1		3.9 ± 1.2		5.2	
(Range)	(2.5-10.4)			(1.2-6.6)			
Height	3.6 ± 1.4	0.9		1.1 ± 0.2		1.6	
(Range)	(0.9-7.7)			(0.4-2.2)			
Flatrock Point							
Length			4.8 ± 1.9		3.5	4.8 ± 1.2	
(Range)			(1.8-8.4)		(2.5-4.4)	(2.3-7.5)	
Height			1.5 ± 0.8		1.2	1.5 ± 0.5	
(Range)			(0.7-3.4)		(0.8-1.5)	(0.5-3.6)	
Size of the Maximum Known Specimen (Draper, 1969, 1973; McLean, 1966; Fritchman, 1960)							
Length	12.1	35.1	52.6	53.6	42.0	26.0	68.7
Height	10.8[1]	17.7	21.0	21.8	12.0[1]	9.0[1]	19.5

[1]Not the same specimen for height and length

limpet species showed no correlation between limpet and *Tegula* size.

DISCUSSION

Collisella asmi was not the only species of limpet found on *Tegula funebralis* and was not the most common species at any of the localities studied. However, of the 7 species found, no adult limpets other than *C. asmi* occurred on *T. funebralis*. The *Tegula* shell may thus serve as a microhabitat for juvenile limpets, a situation perhaps comparable to some algal holdfast communities which are known to have large numbers of juvenile invertebrates, including limpets (J. T. Carlton, personal communication).

As the entire size range of *Collisella asmi* was matched by the other limpets occurring on *Tegula funebralis*, the limpets may be in competition for food and space. The *Tegula* shell has a limited supply of encrusting algae (Brewer, 1973). Limpets identified as *C. asmi* by Eikenberry & Wickizer (1964) were found to move from one shell to another as frequently as within 24 hours, perhaps in search of a new food source.

The presence of only juvenile limpets of non-*Collisella asmi* species on *Tegula* shells suggests they move off the turban snail after attaining a certain maximum size. This may be due to several limiting factors, one of which may be the amount of food available to the growing limpet. However, a more important factor causing the migration of non-*C. asmi* limpets off *Tegula* as they mature may be

the inability to fit their increasingly larger shells onto the *Tegula* shell, resulting in a poor seal and insufficient attachment surface. This probable migration may be similar to juvenile *C. pelta*, a limpet on the brown alga *Egregia*, moving to adjacent rocks after growing too wide for the *Egregia* blade (McLean, 1966).

Previously published works which have identified all limpets on *Tegula funebralis* as *Collisella asmi* may have been based in part on limpets other than *C. asmi*. As noted previously, McLean (1966) recorded that *C. strigatella* occurred on *T. funebralis* abundantly at Pacific Grove. In contrast, Alleman (1968) and Eikenberry & Wickizer (1964) did their work at Pacific Grove but did not mention *C. strigatella* or any other identifiable limpet on *Tegula* except *C. asmi*. Moreover, Eickenberry & Wickizer (*op. cit.*; fig. 2) reported specimens used in their study with extremely low height to length ratios, which appeared inconsistent with measurements for *C. asmi* obtained in the present study. In addition, Guernsey (1912) recorded *C. asmi* "on other limpets"; Long (1968) found *C. asmi* on the sponge *Halichondria panicea*; Keen & Doty (1942) and Test (1945) have recorded *C. asmi* from rocks and crevices; Johnson & Snook (1927) referred to *C. asmi* as the "black seaweed limpet." Since *C. asmi* is believed to be stenotopic upon *Tegula* spp. shells, these records also suggest other species may have been involved.

SUMMARY

1. A study was conducted to identify the species of limpets on *Tegula funebralis* on 5 California beaches, and to determine their frequencies and size ranges.

2. Seven species of limpets were found: *Collisella asmi*, *C. digitalis*, *C. limatula*, *C. pelta*, *C. scabra*, *C. strigatella*, and *Notoacmea scutum*. *Collisella asmi* was the only adult limpet on *Tegula funebralis*; all others were juveniles.

3. A maximum of 7 limpets were found on one *Tegula* at Mussel Point, while a maximum of 3 different species were found on one *Tegula* at Flatrock Point.

4. Limpets had a tendency to aggregate together on a *Tegula* at Shell and Doran Beaches, and to a lesser extent at Mussel Point, but not at Duxbury Reef.

5. No correlation between the size of the *Tegula* and the size of the limpet was found.

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